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(54) **ENHANCED EXHAUST SYSTEM**

(52) **U.S. Cl. .... 181/228**

(57) **ABSTRACT**

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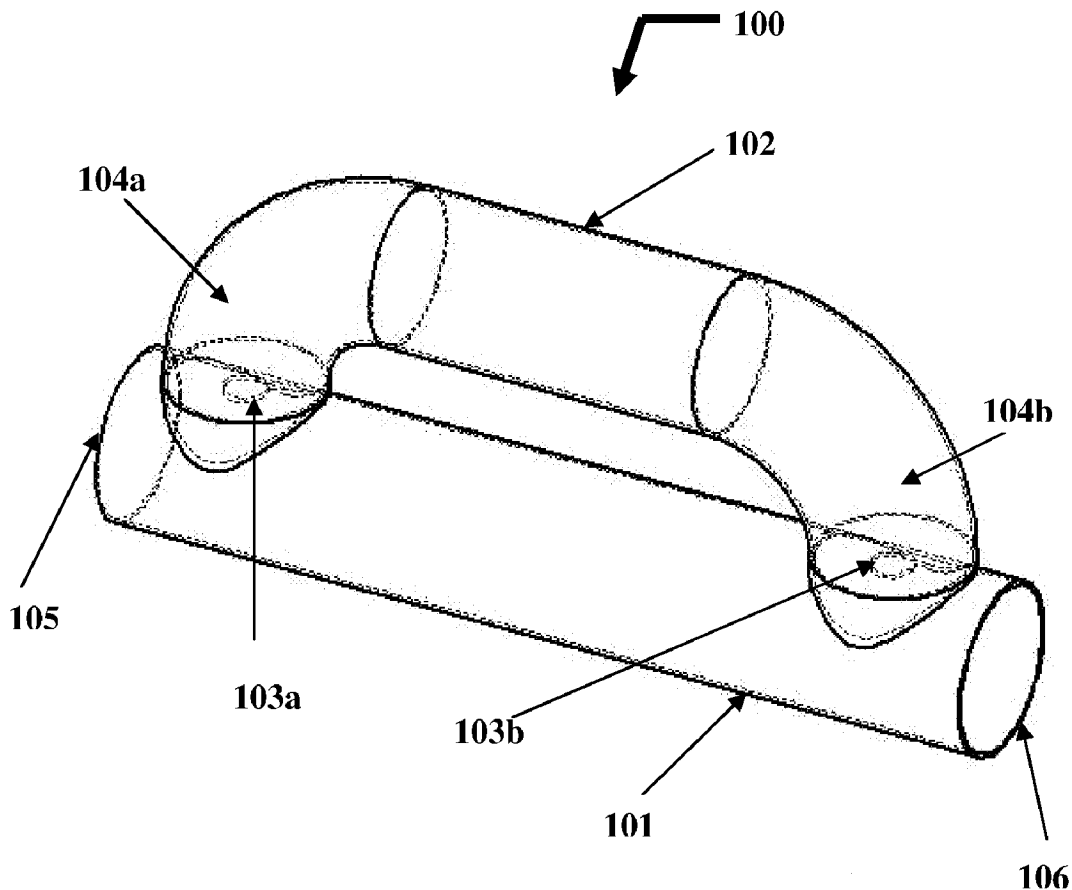
Disclosed herein is an exhaust system and method for improving performance of an internal combustion engine. The exhaust system comprises an exhaust pipe in communication with the internal combustion engine. The exhaust pipe is defined by an annular space. Multiple calibrated orifices are provided on the exhaust pipe. A supplementary pipe is affixed to the exhaust pipe. The supplementary pipe is defined by an annular space. The annular space in the supplementary pipe is in communication with the annular space in the exhaust pipe through the calibrated orifices. The supplementary pipe may be detachably attached to the exhaust pipe. The supplementary pipe regulates flow of fluids and exhaust gases in the exhaust pipe. The supplementary pipe reduces negative torque, attenuates sound emitted from the exhaust pipe, and attenuates noise from exhaust gases discharged from the internal combustion engine. The supplementary pipe improves throttle response, engine power, and engine fuel efficiency.

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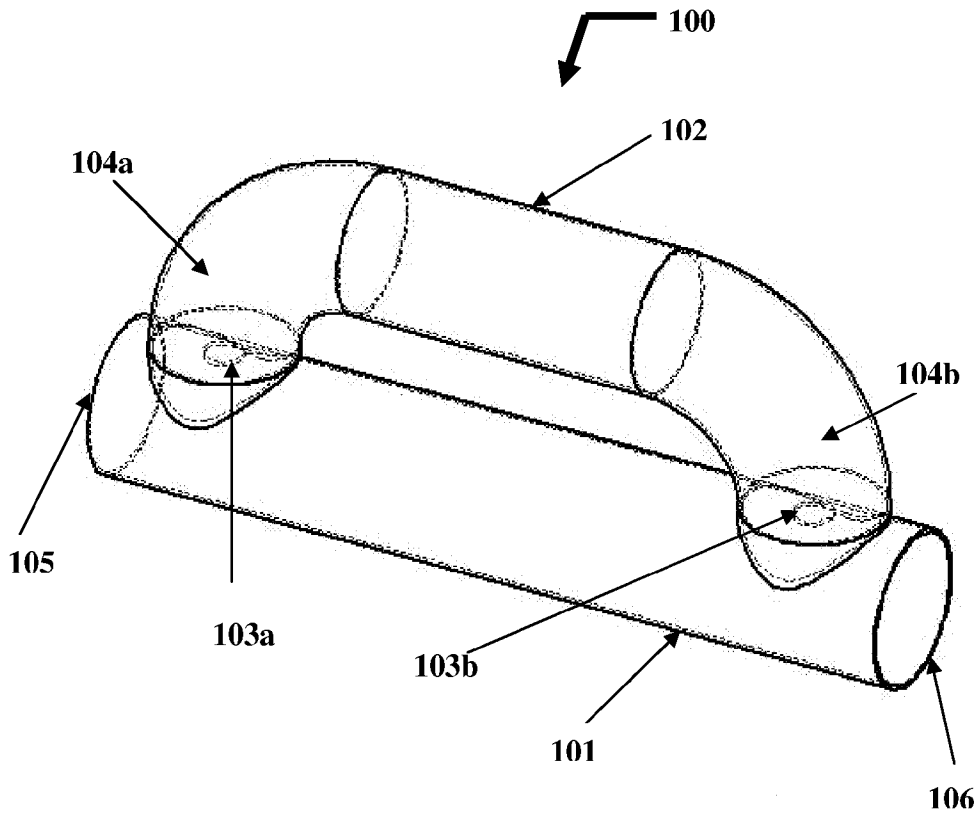


FIG. 1

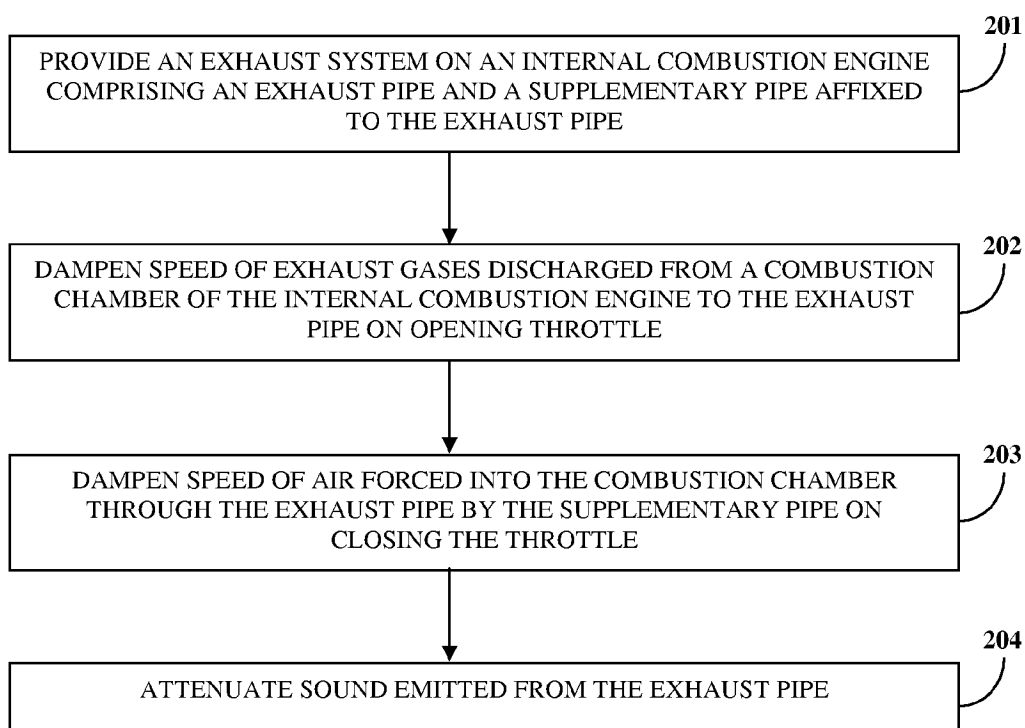


FIG. 2

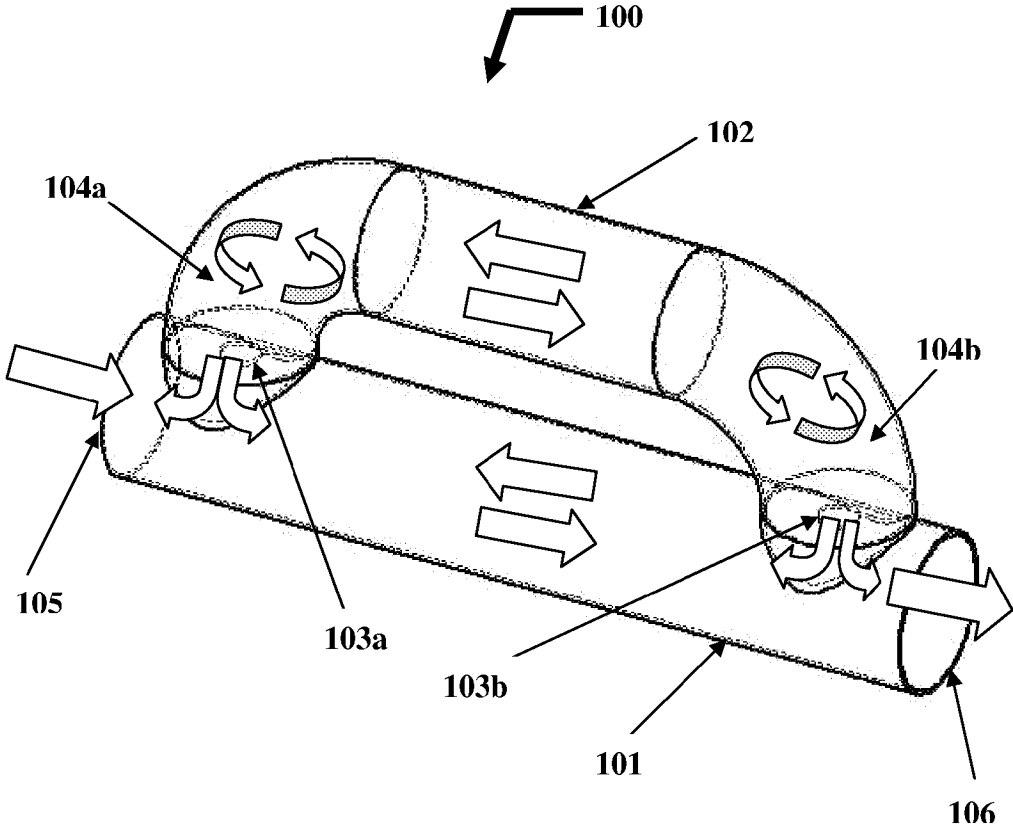


FIG. 3

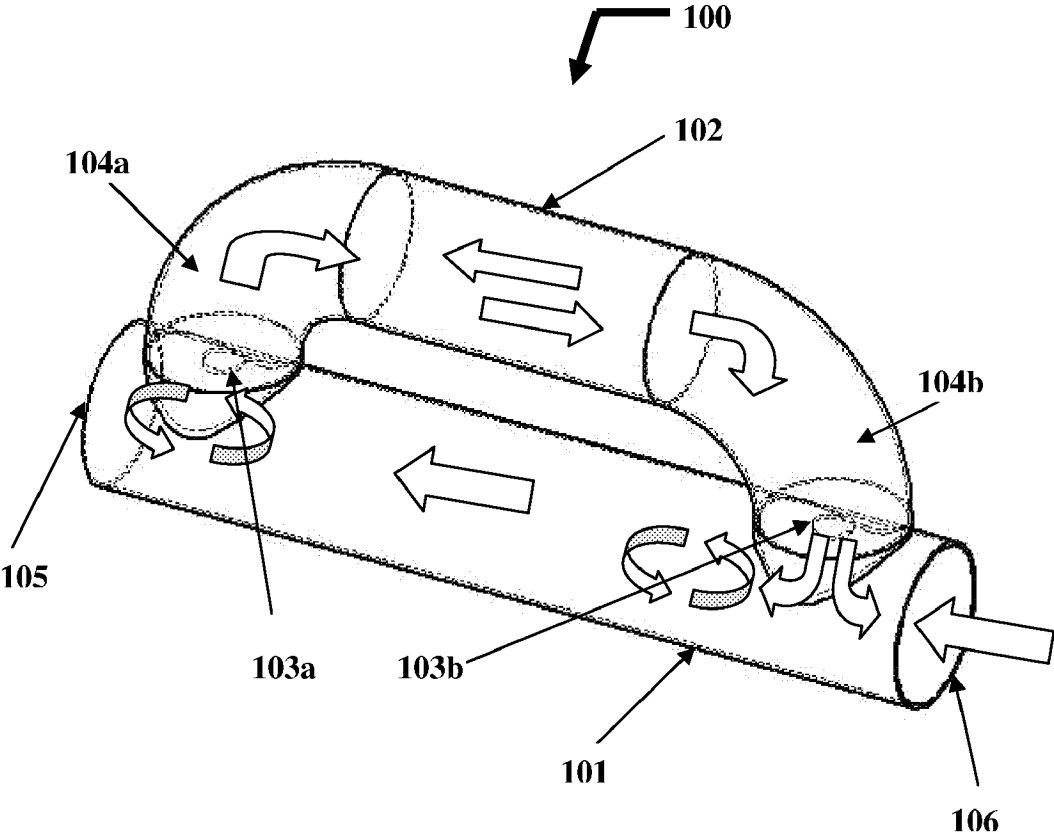


FIG. 4

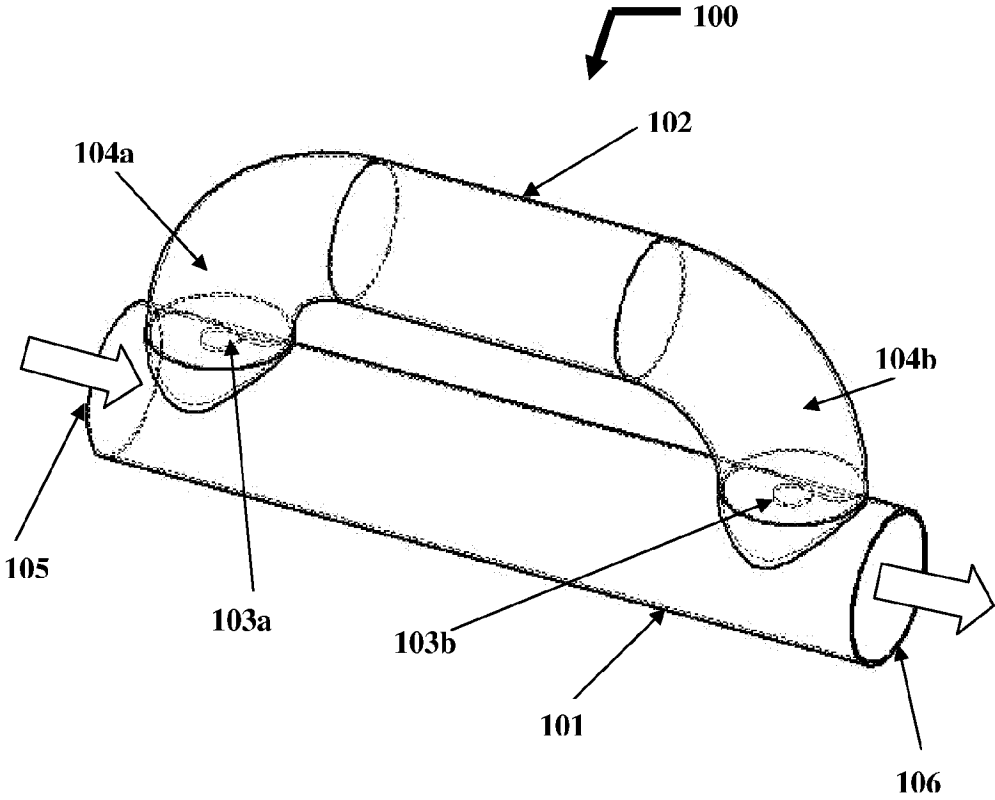


FIG. 5

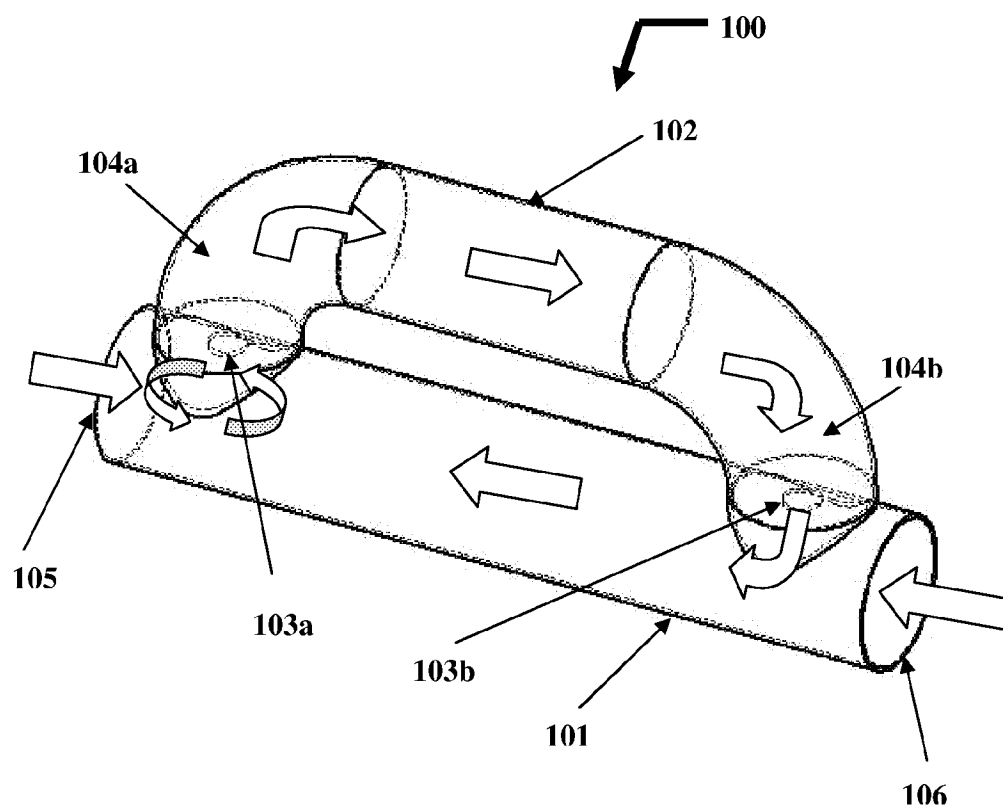


FIG. 6

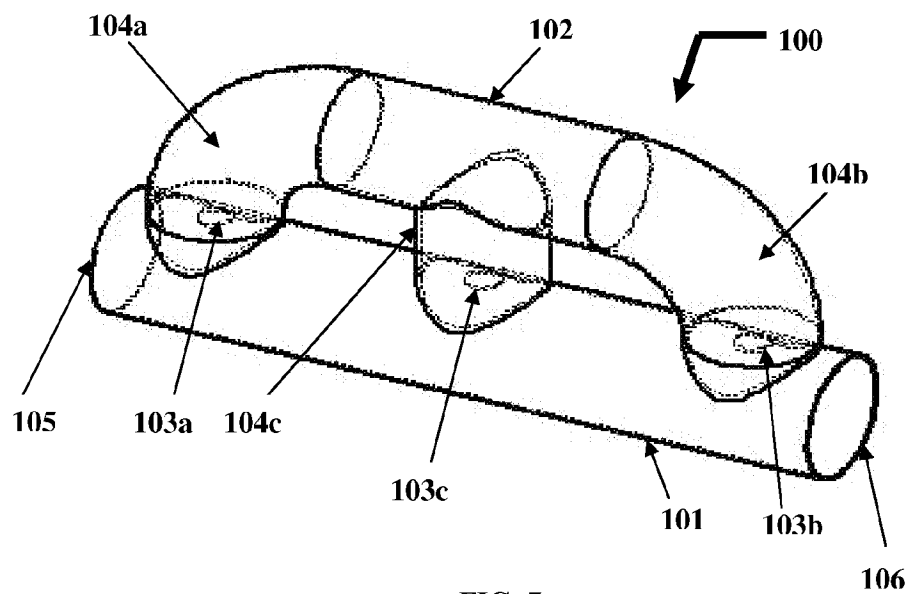


FIG. 7

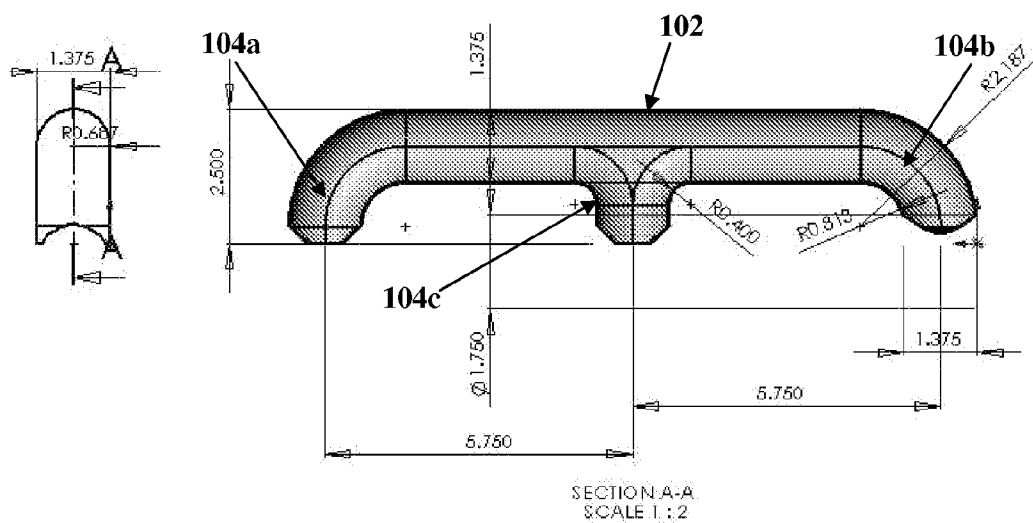


FIG. 8



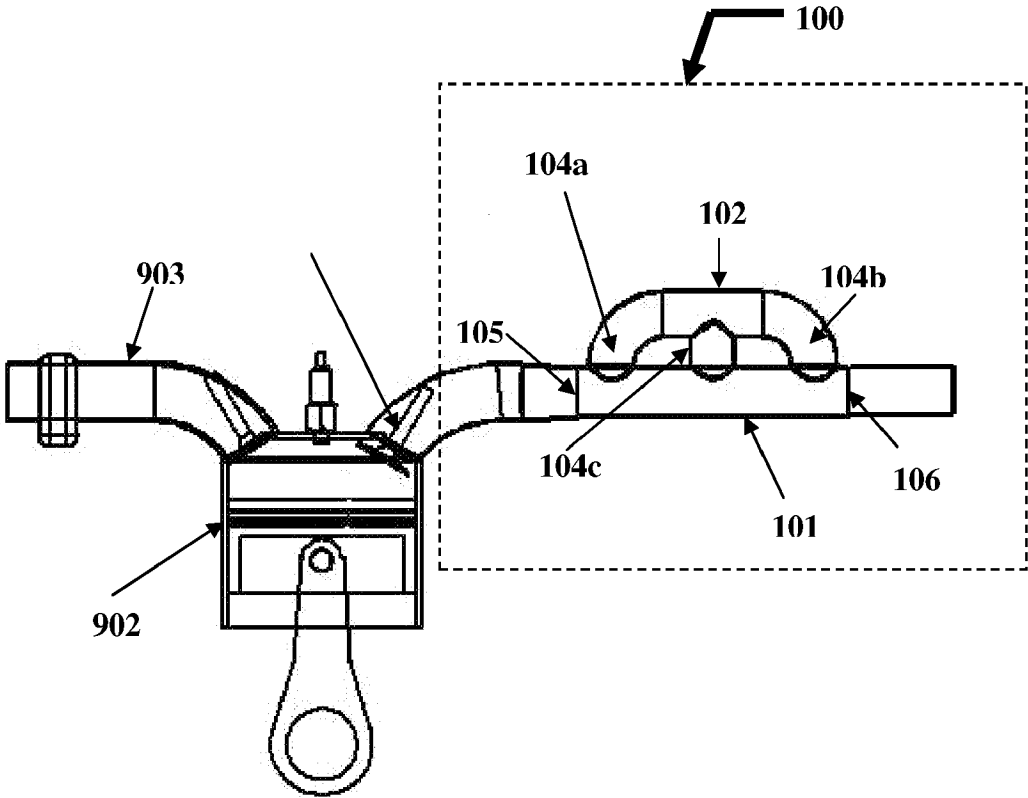


FIG. 9

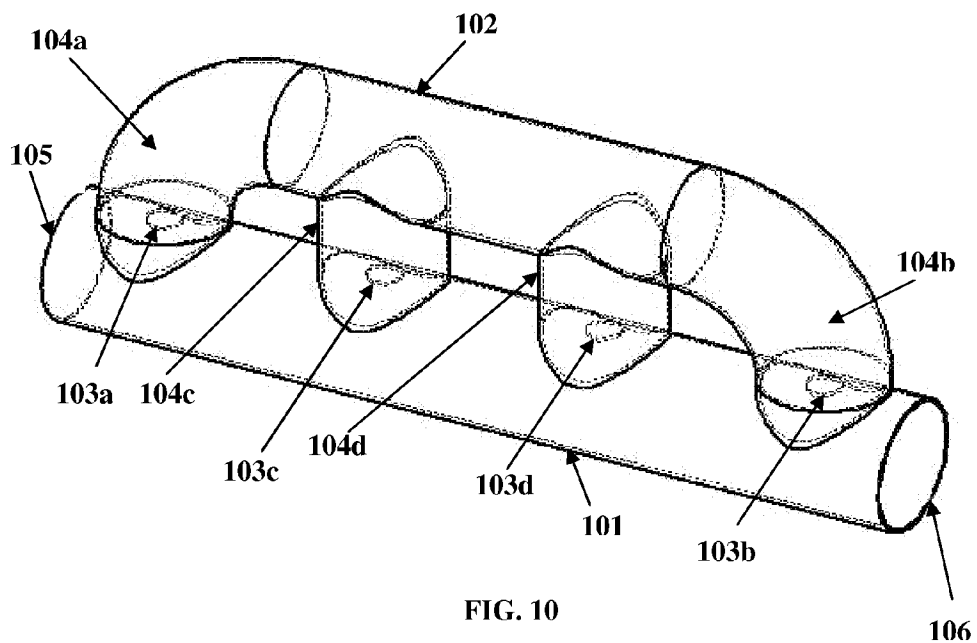


FIG. 10

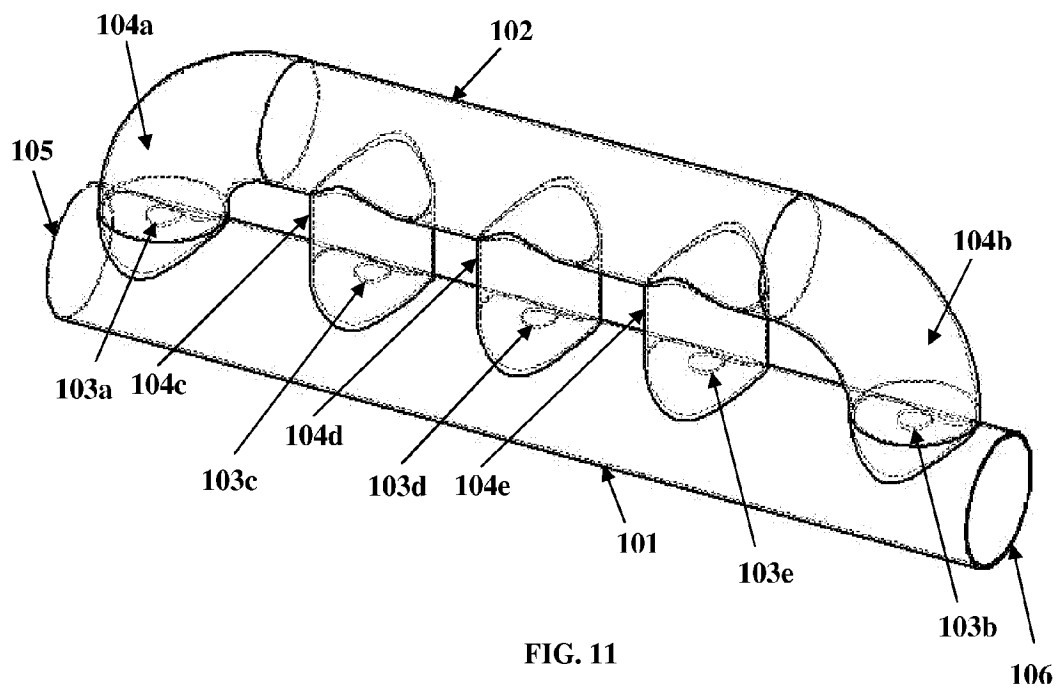


FIG. 11

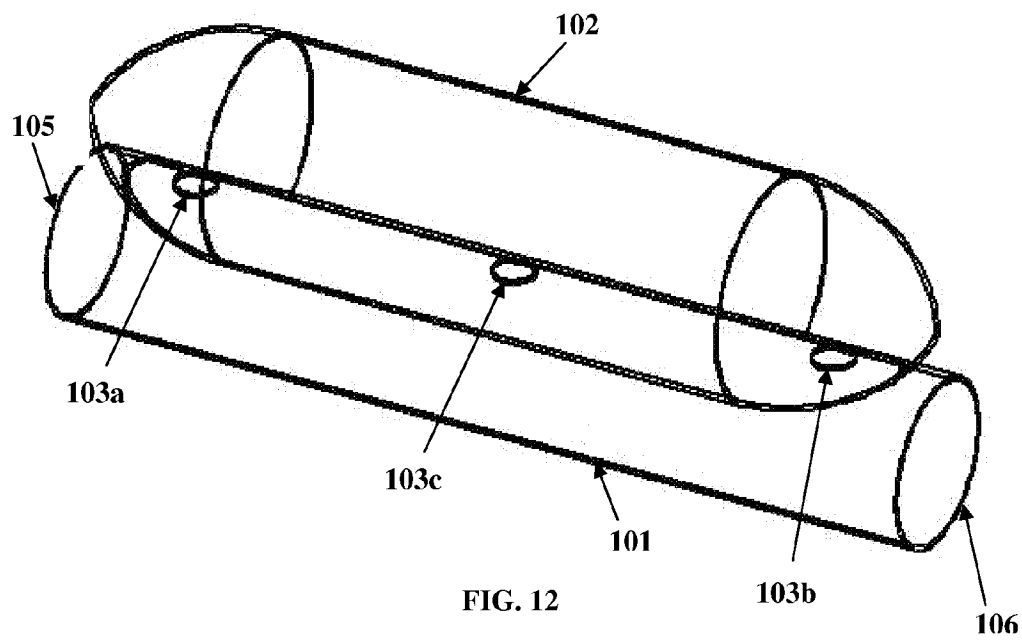


FIG. 12

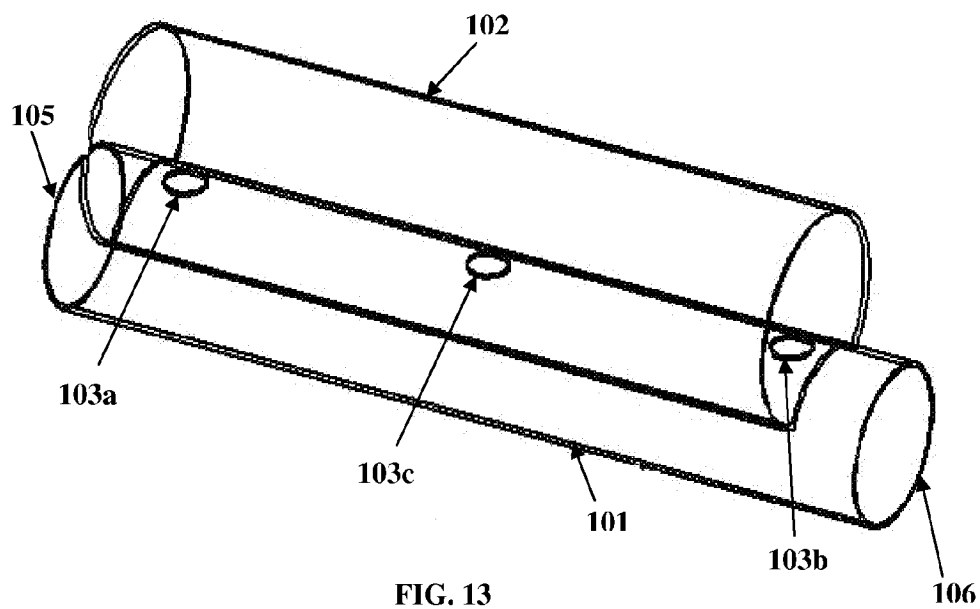
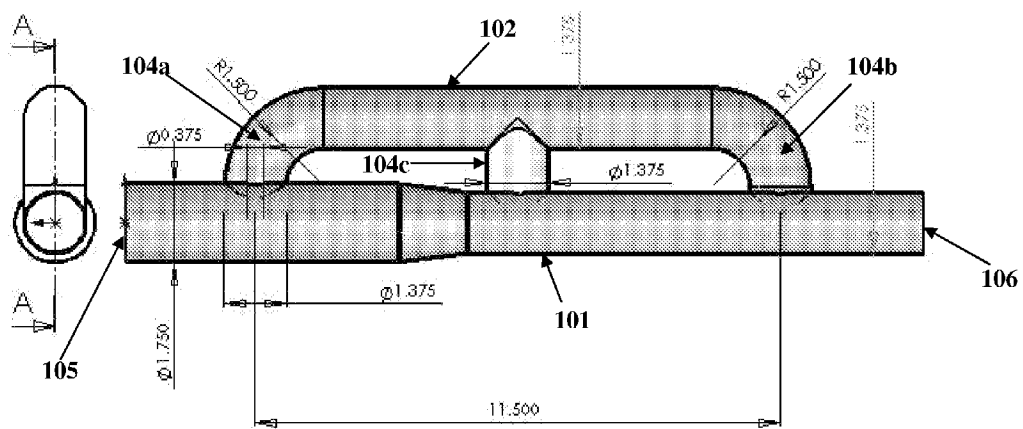
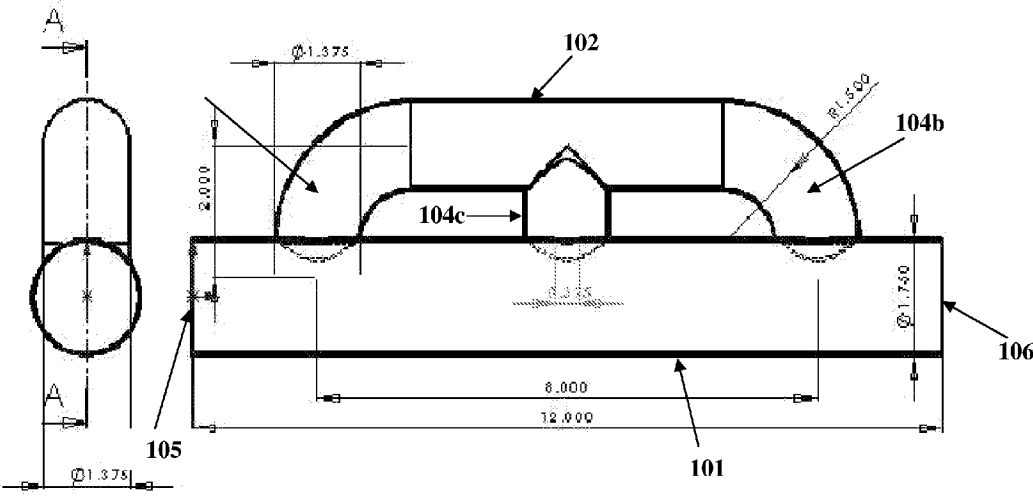


FIG. 13



SECTION A-A  
SCALE 1:2

FIG. 14



SECTION A-A  
SCALE 1 : 1.5

FIG. 15

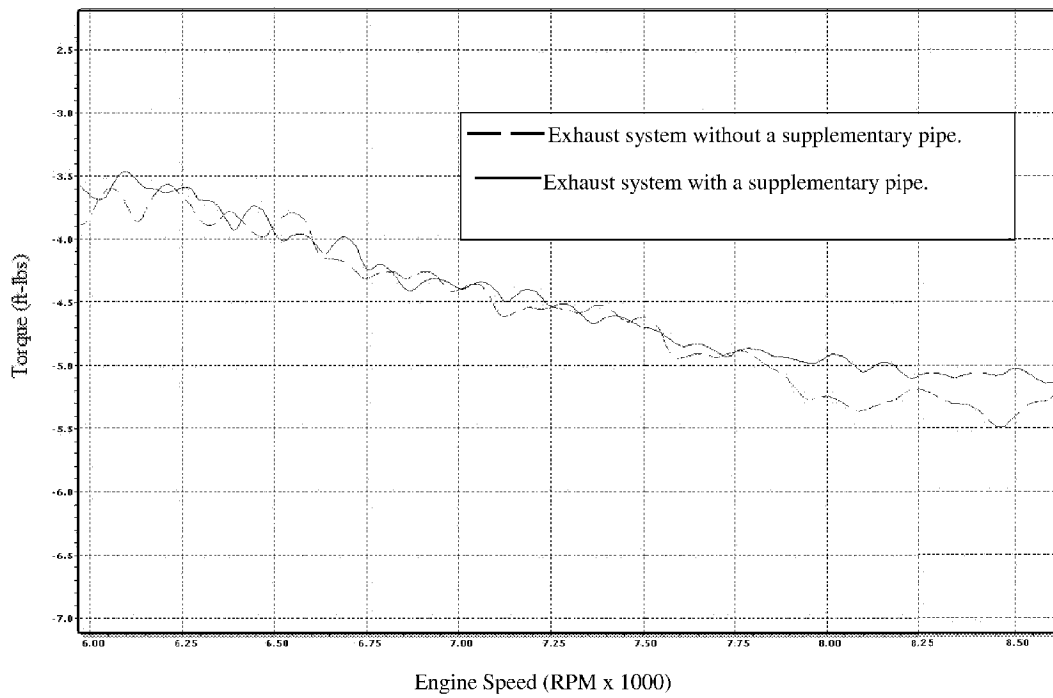


FIG. 16

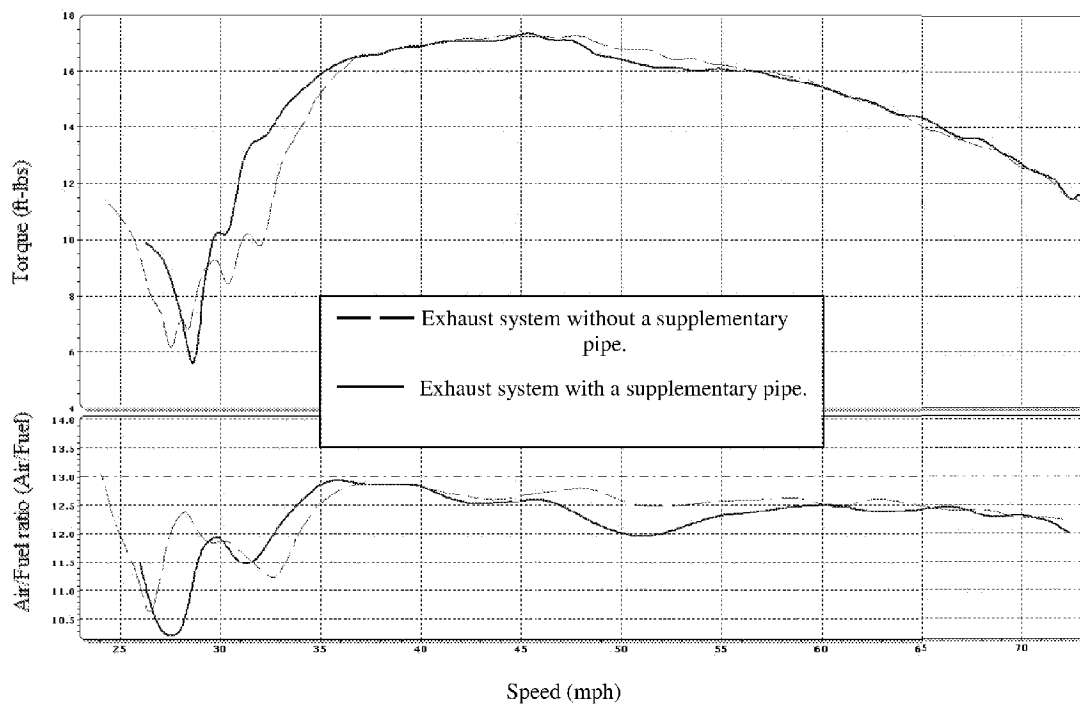


FIG. 17

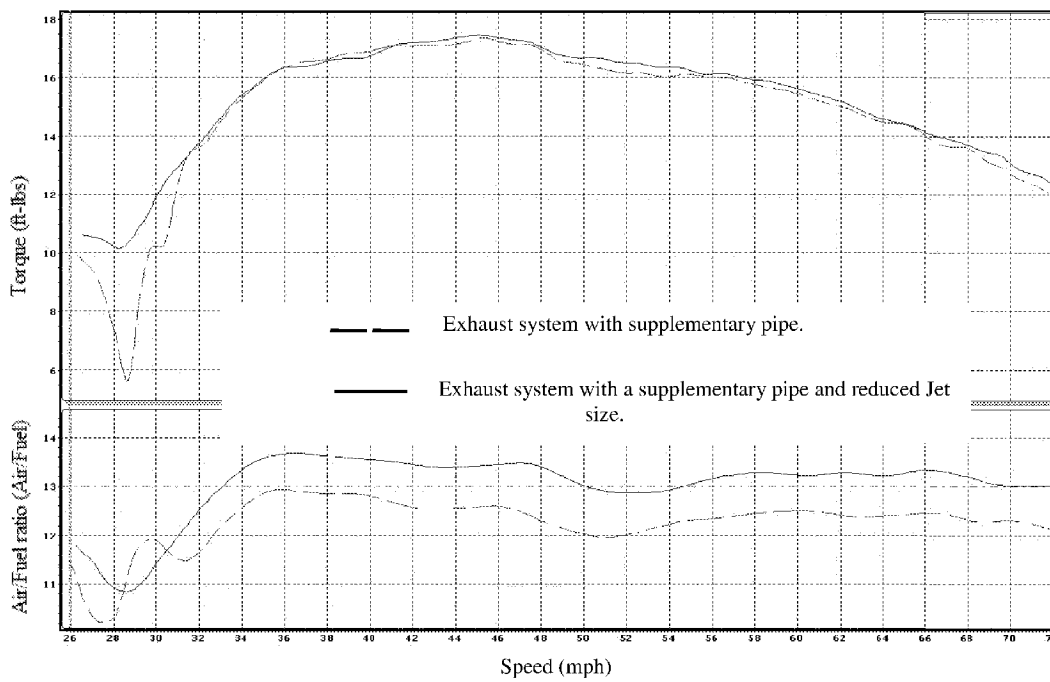


FIG. 18



Speed	Exhaust system without a supplementary pipe	Exhaust system with a supplementary pipe	Change with supplementary pipe fitted and average DB reduction
RPM	DB Reading	DB Reading	
2200	93.2	90.1	3.1
2600	94	92.6	1.4
3000	97	96	1
3300	98.6	95.8	2.8
3600	101.6	97	4.6
3900	102.1	99.3	2.8
4200	101.4	99.2	2.2
4500	101.3	99.1	2.2
4800	103	100.1	2.9
5200	103.4	99.2	4.2
5500	101.2	99.8	1.4
5800	101.9	100.3	1.6
6100	102.4	100.1	2.3
6400	104	101.3	2.7
6700	104	100.9	3.1
7000	105	102.5	2.5
Conditions	90.9* F	91* F	2.55
			2.55 Average Decibel Reduction
Type meter	A type 1 meter by Quest was used. Procedures from the FIM and AMA DB testing was used (A scale, slow response, 20inches @45* from the exhaust exit.		

FIG. 19

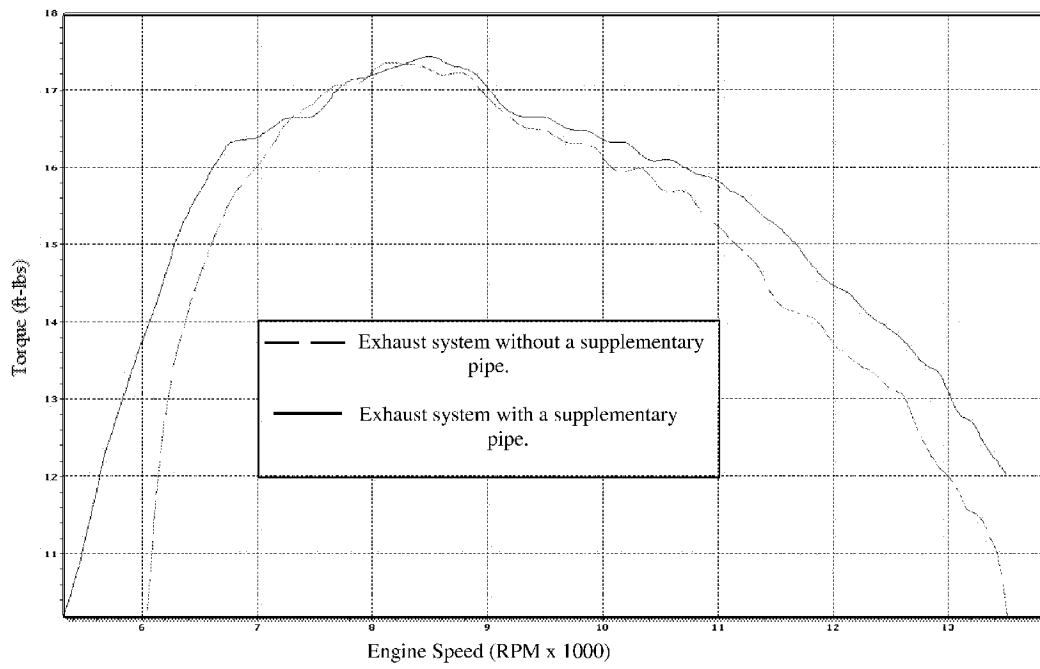


FIG. 20

## ENHANCED EXHAUST SYSTEM

### BACKGROUND

**[0001]** This invention, in general, relates to an exhaust system for an internal combustion engine. More particularly, this invention relates to an exhaust system for enhancing the performance of an internal combustion engine and attenuating noise from exhaust gases discharged from the internal combustion engine.

**[0002]** Internal combustion engine powered devices, for example, automobiles, motorcycles, tractors, trailers, construction and earth moving equipment, etc., require a well designed exhaust system to enhance the performance of the internal combustion engine. Internal combustion engines for motorcycles, automobiles, etc., may also require an enhanced exhaust system to improve the performance of the engine during extreme driving conditions, for example, to instantly accelerate when the throttle is fully opened. The exhaust system may therefore need to accommodate effective throttle response at the instant of acceleration. The motorcycle, automobile, etc. may also need to instantly decelerate from high speeds on closing the throttle. The exhaust system may therefore need to reduce negative torque produced by an internal combustion engine at an instance of deceleration. Performance of the exhaust system also needs to be enhanced to reduce misfires and exhaust gas emissions at full throttle, and to improve fuel efficiency and engine power of the internal combustion engine. Attenuating sound from the exhaust system of automobiles is also desirable.

**[0003]** Hence, there is a need for an exhaust system that improves the performance of the internal combustion engine, attenuates sound emitted from an exhaust pipe, and attenuates noise from exhaust gases discharged from the internal combustion engine.

### SUMMARY OF THE INVENTION

**[0004]** This summary is provided to introduce a selection of concepts in a simplified form that are further described in the detailed description of the invention. This summary is not intended to identify key or essential inventive concepts of the claimed subject matter, nor is it intended for determining the scope of the claimed subject matter.

**[0005]** The exhaust system disclosed herein addresses the above stated need for improving performance of an internal combustion engine, attenuating sound emitted from an exhaust pipe, and attenuating noise from exhaust gases discharged from the internal combustion engine. The exhaust system disclosed herein comprises an exhaust pipe of an internal combustion engine in communication with a supplementary pipe. The exhaust pipe is defined by an annular space. Multiple calibrated orifices are provided on the exhaust pipe downstream from an exhaust port of an engine cylinder of the internal combustion engine. The supplementary pipe is defined by an annular space. The annular space in the supplementary pipe is in communication with the annular space in the exhaust pipe through the calibrated orifices on the exhaust pipe.

**[0006]** The supplementary pipe may comprise multiple tubular extensions in communication with the exhaust pipe through the calibrated orifices on the exhaust pipe. The annular space within the supplementary pipe, the tubular extensions and the exhaust pipe are in communication with one another. The supplementary pipe may be detachably attached

to the exhaust pipe. The exhaust system disclosed herein improves the performance of the internal combustion engine by redirecting the flow of exhaust gases in the exhaust pipe into the supplementary pipe, thereby regulating the flow of exhaust gases in the exhaust pipe of the internal combustion engine. The supplementary pipe reduces negative torque produced by the internal combustion engine and improves throttle response, engine power, and engine fuel efficiency.

### BRIEF DESCRIPTION OF THE DRAWINGS

**[0007]** The foregoing summary, as well as the following detailed description of the invention, is better understood when read in conjunction with the appended drawings. For the purpose of illustrating the invention, exemplary constructions of the invention are shown in the drawings. However, the invention is not limited to the specific methods and instrumentalities disclosed herein.

**[0008]** FIG. 1 exemplarily illustrates an exhaust system for improving the performance of an internal combustion engine.

**[0009]** FIG. 2 illustrates a method of improving performance of an internal combustion engine.

**[0010]** FIG. 3 exemplarily illustrates the altered direction of flow of exhaust gases in an exhaust pipe when the throttle is opened to accelerate an internal combustion engine.

**[0011]** FIG. 4 exemplarily illustrates the altered direction of flow of exhaust gases in an exhaust pipe when the throttle is closed to decelerate an internal combustion engine.

**[0012]** FIG. 5 exemplarily illustrates the unaltered direction of flow of exhaust gases at a high directional velocity in an exhaust pipe during high engine speeds.

**[0013]** FIG. 6 exemplarily illustrates the altered direction of flow of exhaust gases undergoing changes in direction and speed in an exhaust pipe at full throttle at specific engine speeds.

**[0014]** FIG. 7 exemplarily illustrates a supplementary pipe comprising three tubular extensions.

**[0015]** FIG. 8 exemplarily illustrates a sectional design of a supplementary pipe for fabricating the supplementary pipe by stamping.

**[0016]** FIG. 9 exemplarily illustrates positioning of a supplementary pipe on an exhaust pipe with respect to an exhaust valve of an engine cylinder of an internal combustion engine.

**[0017]** FIG. 10 exemplarily illustrates a supplementary pipe with four tubular extensions.

**[0018]** FIG. 11 exemplarily illustrates a supplementary pipe with five tubular extensions.

**[0019]** FIG. 12 exemplarily illustrates an alternative structure of the supplementary pipe affixed to an exhaust pipe.

**[0020]** FIG. 13 exemplarily illustrates another alternative structure of the supplementary pipe affixed to an exhaust pipe.

**[0021]** FIG. 14 exemplarily illustrates arrangement of a supplementary pipe with respect to an exhaust pipe, size of the supplementary pipe, number of tubular extensions of the supplementary pipe, size of the tubular extensions, number of calibrated orifices on the exhaust pipe, and size of the calibrated orifices for a 5 valve 250 cubic centimeter single cylinder engine.

**[0022]** FIG. 15 exemplarily illustrates arrangement of a supplementary pipe with respect to an exhaust pipe, size of the supplementary pipe, number of tubular extensions of the supplementary pipe, size of the tubular extensions, number of

calibrated orifices on the exhaust pipe, and size of the calibrated orifices for a 5 valve 450 cubic centimeter single cylinder engine.

**[0023]** FIG. 16 exemplarily illustrates a graph of variation of negative torque produced by the internal combustion engine measured over a range of engine speeds at closed throttle position of a motorcycle using an exhaust system without a supplementary pipe and an exhaust system fitted with the supplementary pipe.

**[0024]** FIG. 17 exemplarily illustrates a graph of variation of air fuel ratio and engine torque measured over a range of speed of a motorcycle using an exhaust system without a supplementary pipe and an exhaust system fitted with the supplementary pipe.

**[0025]** FIG. 18 exemplarily illustrates a graph of variation of air fuel ratio and engine torque measured over a range of speeds of a motorcycle using an exhaust system fitted with a supplementary pipe and an exhaust system fitted with the supplementary pipe after reducing jet size of fuel in a carburetor of the motorcycle.

**[0026]** FIG. 19 exemplarily illustrates decibel meter readings taken over a range of engine speeds of a motorcycle using an exhaust system without a supplementary pipe and an exhaust system fitted with the supplementary pipe.

**[0027]** FIG. 20 exemplarily illustrates a graph of variation of engine torque measured over a range of engine speed of a motorcycle using an exhaust system without a supplementary pipe and an exhaust system with the supplementary pipe.

#### DETAILED DESCRIPTION OF THE INVENTION

**[0028]** Herein, an exhaust pipe **101** in communication with an exhaust port of an engine cylinder **902** of an internal combustion engine and a supplementary pipe **102** affixed to and in communication with the exhaust pipe **101** is referred to as an "exhaust system". FIG. 1 exemplarily illustrates an exhaust system **100** for improving the performance of an internal combustion engine. The performance of the internal combustion engine may be determined by evaluating the fuel efficiency of the internal combustion engine, engine power generated by the internal combustion engine, negative torque produced by the internal combustion engine, throttle response and sound emitted from an exhaust pipe **101** of the internal combustion engine. A supplementary pipe **102** is affixed to the exhaust pipe **101**.

**[0029]** The exhaust pipe **101** is defined by an annular space. Multiple calibrated orifices **103a** and **103b** are provided on the exhaust pipe **101** downstream from an exhaust port of an engine cylinder **902** of the internal combustion engine. Exemplarily, the calibrated orifices **103a** and **103b** may be located on the exhaust pipe **101** at about 2 cm to about 30 cm from an exhaust valve **901** of an engine cylinder **902** of the internal combustion engine. The calibrated orifices **103a** and **103b** are of a size designed to allow a specific range of air to flow from the calibrated orifices **103a** and **103b** based on requirements of the supplementary pipe **102**, exhaust system design, and engine performance requirements.

**[0030]** Exemplarily, the orifices **103a** and **103b** provided on the exhaust pipe **101** may be calibrated by first placing 6 mm orifices at every 40 mm distance along the length of the exhaust pipe **101** starting from a distance of about 25 mm from the exhaust valve **901** up to a distance of about 1000 mm from the exhaust valve **901**. Readings are taken on each of the orifices **103a** and **103b** provided on the exhaust pipe **101** with a vacuum gauge. The engine speed versus vacuum readings

are then plotted on graph of engine speed versus vacuum. The engine power of the internal combustion engine for the exhaust pipe **101** provided with the orifices **103a** and **103b** is then determined using a dynamometer. Then, deficits in positive and negative torque produced by the internal combustion engine, sound requirements and engine fuel efficiency are determined and optimized.

**[0031]** Cross referencing problem areas from torque graphs illustrating variation of engine torque at different engine speeds with vacuum graphs of the engine speed measured over vacuum, the calibration of the orifices **103a** and **103b** on the exhaust pipe **101** is optimized. Test parts comprising exhaust pipes with altered position and size of the orifices **103a** and **103b** on the exhaust pipe **101** are fabricated and tested. Changing the position and the size of the orifices **103a** and **103b** on the exhaust pipe **101** results in corresponding changes in the torque graphs and the vacuum graphs. The orifices **103a** and **103b** on the exhaust pipe **101** are calibrated by iterative testing and analyzing the torque and vacuum graphs.

**[0032]** The supplementary pipe **102** is defined by an annular space. The annular space of the supplementary pipe **102** is in communication with the annular space in the exhaust pipe **101** through the calibrated orifices **103a** and **103b** provided on the exhaust pipe **101**. The supplementary pipe **102** comprises one or more tubular extensions **104a**, **104b**, **104c**, **104d**, and **104e** in communication with the exhaust pipe **101** through the calibrated orifices **103a** and **103b** on the exhaust pipe **101**. In FIG. 1, the supplementary pipe **102** comprises two tubular extensions **104a** and **104b** to facilitate the flow of exhaust gases between the annular space of the supplementary pipe **102** and the annular space in the exhaust pipe **101** through the calibrated orifices **103a** and **103b** respectively. In an embodiment illustrated in FIGS. 7, 10, and 11, the supplementary pipe **102** may comprise multiple tubular extensions **104a**, **104b**, **104c**, **104d**, and **104e** to facilitate the flow of exhaust gases between the annular space of the supplementary pipe **102** and the annular space in the exhaust pipe **101** through the calibrated orifices **103a**, **103b**, **103c**, **103d**, and **103e** respectively. The supplementary pipe **102** may also be detachably attached to the exhaust pipe **101**. The positioning of the supplementary pipe **102** on the exhaust pipe **101** with respect to an exhaust valve **901** of an engine cylinder **902** of an internal combustion engine is exemplarily illustrated in FIG. 9.

**[0033]** One end of the tubular extensions **104a**, **104b**, **104c**, **104d**, and **104e** terminates in the supplementary pipe **102** and other end on the exhaust pipe **101** at the calibrated orifices **103a**, **103b**, **103c**, **103d** and **103e** respectively as illustrated in FIGS. 7, 10, and 11. The supplementary pipe **102** may also be directly affixed on to the exhaust pipe **101** without the tubular extensions **104a**, **104b**, **104c**, **104d**, and **104e** in different structural configurations as illustrated in FIGS. 12 and 13.

**[0034]** The supplementary pipe **102** is installed on each exhaust pipe **101** of each engine cylinder **902** of the internal combustion engine. For example, if the internal combustion engine is a four cylinder engine and each engine cylinder **902** is equipped with an exhaust pipe **101**, then four supplementary pipes may be affixed, one on each of the four exhaust pipes. The supplementary pipe **102** may be fabricated by bending a tube of an appropriate diameter. The supplementary pipe **102** may also be fabricated by stamping a sectional design of the supplementary pipe **102** as illustrated in FIG. 8. The supplementary pipe **102** may also be fabricated by

machining or casting the supplementary pipe 102. The supplementary pipe 102 may be designed to be installed on different exhaust pipes of internal combustion engines with different configurations. The supplementary pipe 102 may be cylindrical in shape. The supplementary pipe 102 may also be fabricated in alternative shapes, for example, semi-cylindrical, oval, triangular, hexagonal, etc.

[0035] The arrangement of the supplementary pipe 102 with respect to the exhaust pipe 101, size of the supplementary pipe 102, number of the tubular extensions 104a, 104b, and 104c, size of the tubular extensions 104a, 104b, and 104c, number of calibrated orifices 103a, 103b, and 103c, and size of the calibrated orifices 103a, 103b, and 103c for a 5 valve 250 cubic centimeter single cylinder engine is exemplarily illustrated in FIG. 14. The arrangement of the supplementary pipe 102 with respect to the exhaust pipe 101, size of the supplementary pipe 102, number of the tubular extensions 104a, 104b, and 104c, and size of the tubular extensions 104a, 104b, and 104c, number of calibrated orifices 103a, 103b, and 103c, and size of the calibrated orifices 103a, 103b, and 103c for a 5 valve 450 cubic centimeter single cylinder engine is exemplarily illustrated in FIG. 15. The supplementary pipe 102 may comprise, for example, three, four, or five tubular extensions 104a, 104b, 104c, 104d, and 104e terminating in three, four or five calibrated orifices 103a, 103b, 103c, 103d, and 103e respectively on the exhaust pipe 101, as illustrated in FIGS. 7, 10, and 11. The illustrated dimensions in FIGS. 8, 13, and 14 are provided only by way of example.

[0036] FIG. 2 illustrates a method of improving the performance of the internal combustion engine when the engine is accelerated or de-accelerated. The method disclosed herein provides 201 an exhaust system 100 comprising an exhaust pipe 101 in communication with an internal combustion engine and a supplementary pipe 102 affixed to the exhaust pipe 101 as illustrated in FIG. 1. The exhaust pipe 101 is defined by an annular space. Multiple calibrated orifices 103a and 103b are provided on the exhaust pipe 101. The supplementary pipe 102 is defined by an annular space. The annular space of the supplementary pipe 102 is in communication with the annular space in the exhaust pipe 101 through the calibrated orifices 103a and 103b provided on the exhaust pipe 101.

[0037] The supplementary pipe 102 regulates the flow and pressure of fluids and exhaust gases in the exhaust pipe 101. Enhancement in the performance of the internal combustion engine using the exhaust system 100 depends on engine design, engine displacement, operating range of engine speed, cam shaft design, camshaft timing, exhaust pipe design, arrangement of the supplementary pipe 102 with respect to the exhaust pipe 101, size of the supplementary pipe 102, number of the tubular extensions 104a, 104b, 104c, 104d, and 104e, size of the tubular extensions 104a, 104b, 104c, 104d, and 104e, number of calibrated orifices 103a, 103b, 103c, 103d, and 103e on the exhaust pipe 101, and size of the calibrated orifices 103a, 103b, 103c, 103d, and 103e.

[0038] The supplementary pipe 102 allows the speed and flow of the exhaust gases discharged into the exhaust pipe 101 from a combustion chamber of the internal combustion engine during transition of engine speed, for example when the throttle is opened to accelerate the internal combustion engine to be altered and redirected from the exhaust pipe 101 into the supplementary pipe 102. When the throttle is opened, exhaust gases discharged from the combustion chamber of the engine cylinder 902 generate exhaust gas pulse waves in

the exhaust pipe 101 resulting in high and low pressure zones in the annular space of the exhaust pipe 101. The high and low pressure zones cause abrupt movements of the exhaust gases in the exhaust pipe 101.

[0039] The supplementary pipe 102 dampens and attenuates the exhaust gas pulse waves in the exhaust pipe 101 by diverting the high pressure zones in the annular space of the exhaust pipe 101 to low pressure zones in the annular space of the supplementary pipe 102 through the calibrated orifices 103a and 103b and the tubular extensions 104a and 104b. The bypass flow and altered direction of the flow of the exhaust gases through the supplementary pipe 102 are illustrated in FIG. 3. Pressure levels in the exhaust pipe 101 are attenuated by the re-directing the flow of the exhaust gases between the exhaust pipe 101 and the supplementary pipe 102 resulting in the dampening of the exhaust gases flowing along the exhaust pipe 101.

[0040] The dampened exhaust gases in the supplementary pipe 102 are then discharged in the exhaust pipe 101 through the calibrated orifices 103a and 103b along the path of least resistance. When the throttle is opened, the calibrated orifices 103a and 103b allow the exhaust gases in the exhaust pipe 101 to move in and out of the supplementary pipe 102 through the tubular extensions 104a and 104b as illustrated in FIG. 3. By dampening 202 the speed of exhaust gases discharged from the combustion chamber of the internal combustion engine, the exhaust system 100 facilitates a smooth transition of the engine power and improves throttle response when the throttle is opened.

[0041] The supplementary pipe 102 also dampens 203 the speed of air forced into the combustion chamber when the throttle is closed to decelerate the internal combustion engine. When the throttle is closed, flow of air into the combustion chamber through the intake manifold 903 is reduced thereby abruptly reducing the flow of air through the exhaust pipe 101. The reduced exhaust gas flow through the exhaust pipe 101 creates a change in direction and speed of the exhaust gases. The supplementary pipe 102 dampens the speed of the incoming exhaust gases in the exhaust pipe 101 by redirecting the high pressure zones of the incoming exhaust gases in the exhaust pipe 101 into the supplementary pipe 102 as illustrated in FIG. 4 when the throttle is closed. The diversion and distribution of exhaust gases at high pressure from the exhaust pipe 101 into the supplementary pipe 102 precludes or minimizes the back-flow of exhaust gases from the exhaust pipe 101 into the combustion chamber when the engine is de-accelerated.

[0042] The reduced volume of air entering the combustion chamber results in reduction of the negative torque produced by the internal combustion engine. The supplementary pipe 102 improves the fuel efficiency of the internal combustion engine by reducing the negative torque on deceleration of the internal combustion engine. For example, when the internal combustion engine is accelerated to peak revolutions per minutes (rpm) at full throttle and then decelerated, the supplementary pipe 102 reduces the negative torque produced by the internal combustion engine. In general, the maximum percentage reduction in the negative torque produced by the internal combustion engine occurs during the initial period of deceleration.

[0043] A graph of variation of the negative torque measured over a range of engine speeds of a motorcycle using an exhaust system 100 without the supplementary pipe 102 and an exhaust system 100 fitted with the supplementary pipe 102

is illustrated in FIG. 16. The graph, illustrated in FIG. 16 shows about a 10% reduction in the negative torque produced by the internal combustion engine during the initial period of deceleration when there is maximum drag on the speed of the motorcycle.

**[0044]** When the throttle is closed and the internal combustion engine decelerates, the supplementary pipe 102 minimizes the back-flow of exhaust gases from the exhaust pipe 101 into the combustion chamber and reduces negative torque. When the throttle is opened from the closed throttle position for instant acceleration of the internal combustion engine, the speed of the exhaust gases discharged from the exhaust manifold of the internal combustion engine at 105 in the exhaust pipe 101 is dampened by the exhaust system 100. The dampened speed of the exhaust gases results in reduction of positive torque produced by the internal combustion engine when the throttle is opened to accelerate the internal combustion engine.

**[0045]** The reduction in the negative torque on deceleration when the throttle is closed, coupled with the reduction in the positive torque on instant acceleration when the throttle is opened from the closed throttle position results in smooth transition of the engine power. Consider an example of negative torque produced by the internal combustion engine on deceleration when the throttle is closed to be about -5.5 lbs per square inch. Consider positive torque on instant acceleration when the throttle is opened from the closed throttle position to be about +15 lbs per square inch. The instant change of torque is therefore +20.5 lbs per square inch. If the supplementary pipe 102 reduces the negative torque on deceleration from -5.5 lbs per square inch to -5 lbs per square inch, then the reduced negative torque is about 10%. If the supplementary pipe 102 then reduces the positive torque on instant acceleration from +15 lbs per square inch to about +13 lbs. per square inch, the reduced positive torque is about 13%. The instant change of torque from about -5 lbs per square inch negative torque to about +13 lbs per square inch positive torque is about +18 lbs per square inch. Therefore a reduction of 2.5 lbs per square inch of the instant change of torque by the supplementary pipe 102 results in about 12% smoother transition of engine torque.

**[0046]** The exhaust system 100 further improves the drivability of the automobile, motorcycle, etc., by reducing the instant change in torque. The improved drivability of the motorcycle will instill confidence in a driver of the motorcycle to instantly open the throttle to accelerate without causing the rear tire of the motorcycle to spin.

**[0047]** The supplementary pipe 102 has minimal effect on the exhaust system 100 at high speeds of exhaust gases in the exhaust pipe 101. The unaltered direction of the flow of the exhaust gases with high directional velocity in the exhaust pipe 101 fitted with the supplementary pipe 102 during high speeds of a motorcycle is illustrated in FIG. 5. Maximum acceleration of the internal combustion engine is achieved at full throttle openings at specific engine speeds. The atmospheric pressure at the exhaust pipe vent 106 creates a back flow pressure on the exhaust gases in the exhaust pipe 101. At full throttle and at specific engine speeds the back flow pressure exerted on the exhaust gases tends to override the pressure and flow of air drawn into the intake manifold 903 of the combustion chamber. This change in the pressure at the intake manifold 903 of the combustion chamber creates a low pressure at the intake manifold 903 of the combustion chamber. As the low pressure created at the intake manifold 903 is

lower than the pressure in the exhaust pipe 101, the exhaust gases in the exhaust pipe 101 tend to back-flow from the exhaust pipe 101 to the combustion chamber. The exhaust gas pulse waves mutually collide in regions surrounding the calibrated orifices 103a and 103b of the exhaust pipe 101 as the exhaust gases return to the combustion chamber.

**[0048]** The high pressure zones of the exhaust gas pulse waves in the exhaust pipe 101 are dissipated by transfer of the high pressure zones to the supplementary pipe 102 through the tubular extensions 104a and 104b via the calibrated orifices 103a and 103b. The exhaust system 100 thereby reduces the back-flow of exhaust gases from the exhaust pipe 101 to the combustion chamber. The supplementary pipe 102 further reduces the back flow pressure of the exhaust gases by altering the direction and speed of the back-flow exhaust gases as illustrated in FIG. 6 until pressure at the intake manifold 903 overrides the back flow pressure from the exhaust manifold at 105. The supplementary pipe 102 therefore reduces occurrences of misfires, low power outs, and increased exhaust gas emissions at full throttle at specific engine speeds.

**[0049]** A graph of variation of the engine torque measured over a range of engine speed of a motorcycle using an exhaust system 100 without the supplementary pipe 102 and an exhaust system 100 with the supplementary pipe 102 is illustrated in FIG. 20. The graph, illustrated in FIG. 20 shows a net increase in engine torque over total range of engine speed. The supplementary pipe 102 thereby improves the drivability of the motorcycle and the fuel efficiency of the internal combustion engine along with reduction in the sound emitted from the exhaust pipe 101. The supplementary pipe 102 further enables attenuation of noise from exhaust gases discharged from the internal combustion engine.

**[0050]** Consider an example of an exhaust system 100 without the supplementary pipe 102 and an exhaust system 100 equipped with the supplementary pipe 102 on a motorcycle. Consider an initial engine temperature to be X degree Celsius, motorcycle weight to be Y kg, ambient temperature to be Z degree Celsius, with 1 liter of fuel in the motorcycle. The fuel efficiency of the internal combustion engine may be obtained by the kilometers traversed by the motorcycle on the 1 liter of fuel. The engine power may be measured using a dynamometer and the air fuel ratio may be measured using a lambda meter for accurate results. A graph of variation of the air-fuel ratio and the engine torque measured over a range of speed of the motorcycle using the exhaust system 100 without the supplementary pipe 102 and the exhaust system 100 fitted with the supplementary pipe 102 is illustrated in FIG. 17.

**[0051]** The air-fuel ratio is the ratio of mass of air to fuel present during combustion within the combustion chamber. The graph, illustrated in FIG. 17 shows a gain in the engine power and improvement in the fuel efficiency of an internal combustion engine using an exhaust system 100 fitted with the supplementary pipe 102. The fuel efficiency and engine torque may be improved by reducing jet size of the fuel within the carburetor of the automobile, motorcycle, etc. A graph of variation of the air-fuel ratio and the engine torque measured over a range of speeds of the automobile using an exhaust system 100 fitted with the supplementary pipe 102 after reducing the jet size of the fuel in the carburetor from 178 mm to 162 mm is illustrated in FIG. 18.

**[0052]** The supplementary pipe 102 also attenuates 204 the sound emitted from the exhaust pipe 101. The supplementary pipe 102 re-directs the exhaust gas flow within the exhaust pipe 101 at low speeds of the exhaust gases prior to the exit of

the exhaust gases from an exhaust pipe downstream point through a silencer or a muffler provided on the exhaust pipe 101. Since the air flow is redirected and redistributed in the supplementary pipe 102 from the exhaust pipe 101, the sound emitted from the exhaust pipe 101 is reduced. Sound meter readings taken over a range of engine speeds of an automobile using an exhaust pipe 101 without the supplementary pipe 102 and the exhaust system 100 fitted with the supplementary pipe 102 were taken for a range of about 2200 rpm at idle engine speed to 7000 rpm as illustrated in FIG. 19. The sound meter reading, as illustrated in FIG. 19 shows an average of 2.55 decibel reduction in sound emitted from the exhaust pipe 101 fitted with the supplementary pipe 102.

[0053] The foregoing examples have been provided merely for the purpose of explanation and are in no way to be construed as limiting of the present invention as recited herein by way of example, but is intended to cover any device powered by an internal combustion engine. While the invention has been described with reference to various embodiments, it is understood that the words, which have been used herein, are words of description and illustration, rather than words of limitation. Further, although the invention has been described herein with reference to particular means, materials and embodiments, the invention is not intended to be limited to the particulars disclosed herein; rather, the invention extends to all functionally equivalent structures, methods and uses, such as are within the scope of the appended claims. Those skilled in the art, having the benefit of the teachings of this specification, may effect numerous modifications thereto and changes may be made without departing from the scope and spirit of the invention in its aspects.

I claim:

1. An exhaust system for improving performance of an internal combustion engine and attenuating noise from exhaust gases discharged from said internal combustion engine, comprising:

- an exhaust pipe in communication with the internal combustion engine, wherein said exhaust pipe is defined by an annular space;
- a plurality of calibrated orifices provided on the exhaust pipe;
- a supplementary pipe affixed to the exhaust pipe, wherein said supplementary pipe is defined by an annular space; and
- said annular space of the supplementary pipe in communication with said annular space in the exhaust pipe through said calibrated orifices;

whereby said exhaust system improves said performance of the internal combustion engine and attenuates said noise from said exhaust gases discharged from the internal combustion engine.

2. The exhaust system of claim 1, wherein the supplementary pipe comprises one or more tubular extensions in communication with the exhaust pipe through the calibrated orifices on the exhaust pipe.

3. The exhaust system of claim 1, wherein the supplementary pipe regulates flow of fluids and exhaust gases in the exhaust pipe.

4. The exhaust system of claim 1, wherein the supplementary pipe dampens speed of the exhaust gases discharged from a combustion chamber of the internal combustion engine to said exhaust pipe on opening a throttle to accelerate the internal combustion engine, wherein said dampened speed of the

exhaust gases facilitates smooth transition of engine power of the internal combustion engine and improves throttle response on said acceleration.

5. The exhaust system of claim 4, wherein the supplementary pipe dampens speed of air forced into said combustion chamber through the exhaust pipe on closing said throttle to decelerate the internal combustion engine, wherein the supplementary pipe reduces negative torque and improves fuel efficiency and engine power by said dampening of said speed of said air forced into the combustion chamber.

6. The exhaust system of claim 1, wherein the supplementary pipe attenuates sound emitted from the exhaust pipe.

7. The exhaust system of claim 1, wherein the supplementary pipe is detachably attached to the exhaust pipe.

8. A method improving performance of an internal combustion engine, comprising the steps of:

- providing an exhaust system on said internal combustion engine, comprising:
  - an exhaust pipe in communication with the internal combustion engine, wherein said exhaust pipe is defined by an annular space;
  - a plurality of calibrated orifices provided on the exhaust pipe;
  - a supplementary pipe affixed to the exhaust pipe, wherein said supplementary pipe is defined by an annular space; and
  - said annular space of the supplementary pipe in communication with said annular space in the exhaust pipe through said calibrated orifices; and

dampening speed of exhaust gases discharged from a combustion chamber of the internal combustion engine to the exhaust pipe by the supplementary pipe when a throttle is opened to accelerate the internal combustion engine, wherein the supplementary pipe facilitates smooth transition of engine power of the internal combustion engine and improves throttle response on said acceleration by said dampening of said speed of said exhaust gases; whereby said exhaust system improves said performance of the internal combustion engine.

9. A method improving performance of an internal combustion engine, comprising the steps of:

- providing an exhaust system on said internal combustion engine, comprising:
  - an exhaust pipe in communication with the internal combustion engine, wherein said exhaust pipe is defined by an annular space;
  - a plurality of calibrated orifices provided on the exhaust pipe;
  - a supplementary pipe affixed to the exhaust pipe, wherein said supplementary pipe is defined by an annular space; and
  - said annular space of the supplementary pipe in communication with said annular space in the exhaust pipe through said calibrated orifices; and
- dampening speed of air forced into said combustion chamber through the exhaust pipe by the supplementary pipe when the throttle is closed to decelerate the internal combustion engine, wherein the supplementary pipe reduces negative torque, improves engine fuel efficiency and engine power by said dampening of said speed of said air forced into the combustion chamber;

whereby said exhaust system improves said performance of the internal combustion engine.